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# CHINA'S IMPORT AND ASSIMILATION OF TECHNOLOGY: A SURVEY

*A Report Prepared under an Interagency Agreement*
*by the Federal Research Division,*
*Library of Congress*

April 1984

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## PREFACE

This report considers the factors likely to promote or impede China's assimilation of imported technology. It is intended to help estimate China's ability to absorb technology in various fields, and to gauge the consequences of importing any particular item. It pays special attention to the Chinese context and to the end users of foreign technology. Significant recent (1982 and 1983) transfers of technology in four fields--energy, heavy industry, electronics and computers, and aviation--are surveyed.

Open source materials including studies of technology and technology transfer, US and Chinese press accounts, and a range of business and trade journals were used. Information in this study is current as of 15 April 1984.

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## SUMMARY

Importing foreign technology plays a central role in China's modernization strategy. While the training of Chinese students abroad and the improvement of Chinese science through exchange and cooperation with many foreign countries will have a major long-term effect, more immediate, short-term gains are the result of such commercial transactions as purchases, joint ventures, coproduction, and consulting and industrial training agreements with foreign corporations.

Chinese policy is to import only what it cannot produce for itself and to limit imports to advanced technology and key equipment. The reluctance of foreign corporations to share their advanced technology and foreign governments' restrictions on the export of technology have impeded China's efforts to modernize its industrial structure. An equal if not greater impediment is China's limited ability to assimilate the technology it imports.

Shortages of skilled manpower, poor enterprise management, an economic structure marked by a high degree of compartmentalization and duplication, and a low degree of exchange between enterprises all limit the use of imported technology. The resulting variability and unevenness characteristic of Chinese industry and technology make generalizations about Chinese capabilities in the abstract or aggregate both difficult and misleading. Consequently, the assessment of the effects of the transfer of any technology to China depends on the specific end user within China.

CHINA'S IMPORT AND ASSIMILATION OF TECHNOLOGY: A SURVEY

## 1. INTRODUCTION

### a. Technology and Modernization

Importing foreign technology plays a central role in China's modernization strategy. Premier Zhao Ziyang, addressing the Fifth Session of the Fifth National People's Congress in November 1982, said: "All branches of our national economy must gradually apply the advanced technologies that have been in common use in the economically developed countries since the 1970s or the early 1980s and which are applicable to China."[1]

### b. Modes of Transfer

Foreign scientific knowledge and technology are being pursued through a variety of means. In long-range planning, the most significant method is to dispatch thousands of Chinese students of science and engineering to universities in the United States and other Western countries. This, along with programs of scientific exchange and cooperation such as those covered under the 1979 Sino-US Agreement on Cooperation in Science and Technology, will increase China's research and development capabilities within 5 to 10 years. It will also enhance China's ability to assimilate advanced foreign technology.

Other modes of transfer such as the purchase of computers, offshore oil drilling equipment, or sophisticated machine tools have a more direct, short-term impact. These purchases, however, are limited both by China's shortage of foreign exchange and reluctance to borrow and by its policy of trying, whenever possible, to purchase manufacturing technology rather than finished products. Hence China has attempted to promote joint-venture and coproduction arrangements with foreign corporations. Chinese efforts to acquire some types of technology have been hampered by the reluctance of foreign corporations to divulge their most advanced technology and by foreign governments' restrictions on the export of technology.

### c. Technology in US-China Relations

The Chinese Government has been sensitive to attempts to impede or limit the flow of technology to China because of the importance of technology transfer to China's modernization and economic development. In 1982 and 1983 the level of technology the United States was willing to permit China to acquire as well as the need to clear exports through the Coordinating Committee for Multinational Export Control (COCOM) have been major issues in US-China relations. The 1983 US decision to place China in the "V Category" of friendly nations under the Export Administration Act of 1979 and so liberalize export restrictions has reduced Chinese dissatisfaction and contributed to improved relations. The issue remains, however, and will probably continue to be a point of disagreement and negotiation in the future. Restrictions are still placed on sales of certain products and technology which are viewed as national security concerns by the US Government. Nuclear weapons, electronic warfare, antisubmarine warfare, and intelligence gathering have been cited as technologies which will continue to be subject to export bans.[2] It is not yet clear what the Chinese will attempt to purchase or what items will receive export permits.

Since technology transfer is so important to the current state of US-China relations, and since questions of military applications of technology are at the root of US restrictions on technology export, some notion of what the Chinese desire, what is in fact being transfered to China, and to what use it is likely to be put is necessary.

## 2. CHINA'S TECHNOLOGY IMPORT POLICY

### a. Buying Know-How Rather Than Products

China's present policy is to maximize the flow of foreign technology in order to achieve rapid economic growth. China tries to import only what it cannot produce for itself, and to limit imports to advanced technology and key equipment.[3] In general the plan is to import as advanced technology as possible, yet still suitable to Chinese conditions. Under the Sixth Five Year Plan (1981-85), the emphasis is on raising the technical level of existing enterprises rather than importing complete plants or equipment for showcase projects. Many of China's existing factories are using outmoded or obsolete equipment and techniques and, partly for this reason, are very inefficient, requiring large quantities of energy and materials to produce mediocre or outmoded goods. Whenever possible, the Chinese will attempt to acquire technology and know-how rather than finished products.

### b. Policy Alternatives

Within these policy guidelines, there is room for considerable disagreement within the Chinese Government regarding what level of technology is "appropriate" or "applicable" to Chinese circumstances. Issues involved in the policy debate are self-reliance versus dependence on the international system, short-term versus long-term planning, basic research versus applied technology, and agriculture versus heavy industry. Questions on the scope, pace, and content of technology import have been and may well continue to be major issues in China's internal politics. Modifications of the current policy are almost certain and major changes are not unlikely.

Questions of what and how much foreign technology to import have been major issues in Chinese politics since the mid-19th century. China has had a great deal of experience importing foreign knowledge and expertise, and this experience presumably influences present policies and policy debates.

### c. Historical Experience

Throughout the 19th and early 20th centuries a great deal of money was spent importing foreign artillery, warships, and even aircraft. Chinese forces equipped with imported weaponry were defeated regularly by foreign armies, and the possession of modern foreign arms did not preserve the Nationalist government from defeat at the hands of less well-equipped Communist armies. In many cases from the 1850s through the 1940s, Chinese authorities purchased foreign weapons which were either overpriced, out-of-date, or inappropriate to Chinese conditions. Consequently, the wary attitude the Chinese authorities have taken recently toward the purchase of foreign arms is not difficult to understand.

It became increasingly clear that foreign technology could not simply be imported piecemeal and used to replace a few domestically produced items. Science and technology are systems and their use demands a host of often unanticipated modifications to a range of social institutions--everything from the educational system to promotion policies within the military. The dilemma for the Chinese has been that they could either purchase a few foreign items, such as cannons or railway engines, and be dependent on foreigners to produce and repair them, or they could attempt to produce them internally, and be forced, step by step, to reform or modify Chinese institutions, making them more like foreign ones. The possible alternative, a policy of self-reliance and self-sufficiency, eventually leads to renewed recognition of the factors which have compelled China to import foreign technology since the Opium War--the threat of foreign aggression and the humiliating recognition of national backwardness.

d. Soviet Aid in the 1950s

Thus far the single most comprehensive attempt at importing and assimilating foreign technology was that of the 1950s. As part of the First Five Year Plan (1953-57) China was the recipient of "what was undoubtedly the most comprehensive technology transfer in modern industrial history."[4] The Soviet Union provided aid for 156 major industrial projects concentrated in mining, power generation, and heavy industries. Following the Soviet "Big Push" model of economic development, these were large-scale, capital-intensive projects. Between 1950 and 1960 some 11,000 Soviet specialists and scientists worked in China, and 38,000 Chinese (20,000 workers, 8,000 technicians, 7,500 students, 1,300 scientists, and 1,200 instructors) were trained in the Soviet Union.[5] Furthermore, China's industrial, educational, and scientific systems were reorganized along Soviet lines. During this era, China made substantial progress in fields such as steel, machine building, basic chemicals, and the production of military goods such as artillery, tanks, and jet aircraft.

e. Long-Term Costs

Soviet assistance, however, had some less than ideal consequences. The cost of dependence on a single foreign source was brought home when Moscow suddenly cancelled its aid and technology transfer programs in August 1960, leaving many projects unfinished and terminating the supply of essential goods. This experience doubtless encouraged some Chinese leaders to advocate increased or extreme self-reliance. Other consequences have since become apparent. The primary goal of the 1950s program was rapid industrial growth, and the development of China's science and technology was distinctly secondary. Most of the Soviet experts in China were engineers and technicians, and most of the training the Chinese received was narrowly focused and directed at immediate application. As a consequence, the Chinese were able to operate the Soviet factories, but their capacity for independent design and development remained very limited. China also adopted Soviet-style economic and industrial systems. Such systems produce rapid growth in a few key sectors, but growth slows down as the effects of unbalanced development are felt. In addition, Soviet organization of science, in which scientists work in academies separated from universities and industries, makes the translation of scientific knowledge into new products and processes both difficult and lengthy. One of the unintended legacies of the 1950s program of technology transfer and training has been an industrial system capable of reproducing large quantities of products designed in the Soviet Union, Czechoslovakia, Hungary, and Romania in the 1950s and 1940s, but with very limited

capabilities for innovation or product development. Hence the need in the 1980s for another round of wholesale technology transfer, and policies that avoid the errors of the 1950s.

## 3. TRANSFERRING TECHNOLOGY TO CHINA

### a. Limits to China's Assimilation of Technology

The most effective mechanisms of technology transfer are those that permit long-term relationships and extensive consulting and trouble-shooting between donor and recipient, as was done with some of the Soviet technical aid programs to China.[6]

China's ability to assimilate technology is limited by such factors as shortage of skilled manpower, inadequate management, an economic structure marked by a high degree of compartmentalization and duplication, and a low degree of exchange between enterprises. As in the Soviet Union, China's enterprises attempt to maximize self-sufficiency through stockpiling and building their own spare parts, instruments, machines, and other items that are difficult to obtain. Movement of personnel and diffusion of knowledge between enterprises is very rare. The absence of standardization within and between enterprises hinders the integration of up-to-date imported technology.

The effective assimilation of imported technology depends to a large degree on the recipient's technical skills. Even the superficially simple process of copying or reverse engineering demands skills approaching those of the original producer. Chinese engineers and technicians, many with only limited formal education, have learned to work successfully in circumstances where they have little contact with their peers in other enterprises, cannot buy equipment or materials in the market, and use assemblages of obsolete, imported, and homemade equipment. According to one Western observer:

> China has developed a cadre of versatile technical personnel capable of trouble-shooting and overcoming a variety of technical problems. One shortcoming of this group, however, is that it tends to be more in the mold of the 'artisan-craftsman' and therefore lacks the technical training and depth of understanding that is characteristic of its Western counterparts.[7]

Another analyst noted:

> What the Chinese lack is not the ability to manufacture. They manufacture quite well with custom building, hand-machining, and small-scale batch-type production. What they have not mastered are the techniques of modern, continuous-flow production processes, precise automation technology, and other organizational aspects of management technology.[8]

### b. Variation and Variability Within China

A consequence of the self-sufficient and compartmentalized nature of Chinese enterprises is the considerable variation and unevenness in the level of

technical skill. Knowledgeable travelers to China often report that of the factories or laboratories they visited, one or two looked well-run while others were 10 to 20 years behind world standards. Similarly, some scientific or technical fields are reported to be well developed, while others are backward or hardly exist at all. Making generalizations about Chinese capabilities is both difficult and unwise. The assessment of the effects of the transfer of any technology to China depends on precisely where the item is going--its end user. Some enterprises are able to make good use of an item of foreign technology, while others in the same field probably lack the skill to assimilate it. Compartmentalization and restricted communication between enterprises means that diffusion of technology within China is as great a problem as assimilating advanced foreign technology.

## 4. SIGNIFICANT TRANSFERS OF TECHNOLOGY, 1982 and 1983

### a. Energy Technology

A shortage of energy is one of the major obstacles to China's economic development; hence the plan for quadrupling total economic output by the year 2000 envisages a massive infusion of foreign energy technology. It was reported in early 1983 that the energy shortage "had idled about 20 percent of the industrial equipment in recent years, resulting in an annual loss of 70,000 million yuan (US $36.4 billion) in industrial output value."[9] Under the Sixth Five Year Plan (1981-85) energy development is to receive 25 percent of the total funds for capital investment. The goal is to double energy output by 2000 while achieving major advances in energy conservation.[10] Foreign technology is necessary to meet these goals.

#### (1) Coal

China has massive deposits of coal which remain the foundation of the country's energy economy. In 1982 coal accounted for 71.2 percent of China's primary energy output. China's 1982 coal output was 666 million tons. Over 300 million tons were produced by over 500 large mines directly controlled by the State, while nearly 300 million tons came from 19,500 mines run by localities, ranging from provinces to communes. There are 4.6 million coal miners, .5 million of whom work on capital construction.[11] Although the output of China's mines has increased markedly since the 1950s, coal mining has, in contrast to the petroleum industry, received relatively little investment. Increases in production have come from the development of many small-scale and technologically unsophisticated mines and from intensive, short-run working of existing mines. In the 1970s, the development of new mines or even new tunnels in existing mines was neglected.

Only half of China's coal is extracted, conveyed, or loaded by mechanical means. Ninety-six percent of China's coal comes from underground mines, rather than open-pit or strip mines that extract more of the available coal. In the 1950s China began to use the modern long-wall system of mining, which recovers 70 percent of the coal in a seam; however, many mines still employ the older room-and-pillar method, which recovers only 50 percent of the coal. Part of the problem is the inability of China's machine building industry to produce mechanized mining equipment in significant quantities.[12]

Furthermore, while the coal industry has concentrated on increasing tonnage, little has been invested in coal processing facilities. This results in coal which contains a high proportion of rock and other impurities. Of the estimated 642 million tons produced in 1982, only 51 million tons were washed. A January 1983 State Council decree ordered all major coal mines to begin supplying processed coal in 1983.[13]

China plans to double coal output by 2000. This will not require a major technological breakthrough, but it will depend on foreign funds and substantial imports of existing foreign technology. Mines in the major coal center in Shanxi Province produce less than a ton of coal per worker per day. In underground mines American workers produce 10.75 tons per day, while surface mines average more than 30 tons per worker per day.[14] China seeks foreign assistance in developing complete mines, especially surface mines, as well as foreign mechanized mining and coal processing equipment. But, there have been problems assimilating the mining machinery imported during the 1970s. In 1981 the Ministry of Coal Industry said that only 83 of the 150 sets of mechanized coal equipment imported in 1978 were still operating 3 years later. It blamed inadequate planning and maintenance. The Chinese would like to import production lines and technology for mining machinery, and pay for this in coal. The problem is that most countries that produce coal mining machinery also export coal and have no interest in China's coal.[15]

Appendix A presents a list of coal technology transfers to China in 1982 and 1983.

(2) Oil

During the 1950s, China produced a small quantity of oil from the Yumen field, Gansu Province, but imported most of its petroleum from the Soviet Union. Development of the Daqing oilfield in Heilongjiang Province began in 1960, and by 1968 China achieved self-sufficiency in oil production. By 1980 oil provided 25 percent of China's energy and natural gas a further 3 percent.[16]

Initially all Chinese oil equipment came from the Soviet Union and Romania and reflected Soviet technology of the 1950s. The oil industry has been a priority sector for investment since the early 1960s, and great efforts have been made to manufacture equipment. Still, foreign observers generally agree that neither Chinese equipment nor extraction practices are up to current world standards. Equipment is insufficiently standardized and maintenance problems are common. While the Daqing field, China's largest, is relatively shallow, deep drilling shows the deficiencies of Chinese equipment. Offshore exploration and drilling is even more difficult, and here China has decided to rely primarily on the expertise of foreign oil companies.[17]

China's crude oil production, after increasing rapidly throughout the 1970s, apparently has peaked and begun to decline. By 1990 China may actually be an importer of oil. The reasons for the decline involve geology, technology, and management.

Onshore fields, especially in northeastern China (Daqing, Shengli, Dagang), produce oil that is found in large numbers of small reservoirs. The reservoirs are difficult to spot on seismic profiles, must be hit exactly with

the drill, and once found are quickly drained. They require a relatively large number of individual wells which have a low yield (average about 200 barrels a day). The crude oil is waxy with a high residual content that complicates handling and refining.[18] The sedimentary basins of western China's Xinjiang Uygur Autonomous Region appear promising and may contain larger reservoirs of oil, but both prospecting and eventual exploitation are made difficult by distance and the absence of any infrastructure in these remote deserts. Even if substantial quantities of oil were to be discovered in this area, it would probably require at least 10 years before it could be supplied to industries and cities thousands of kilometers to the east. China's oil surveying technology lags considerably behind world standards, as does its drilling technology, especially deep drilling. China's ability to recover the maximum amount of oil from each field also falls short of current world practices. Because of management errors in the 1970s, short-term output was maximized at the expense of long-term recovery. Sophisticated techniques for enhancing recovery are now necessary.[19]

Consequently, China is now importing foreign technology and expert services in three major fields: seismic surveying, onshore drilling and oil recovery techniques, and offshore exploration and drilling. This is done primarily through cooperation with foreign oil corporations attracted by the hope of a share of the oil. The authorities have attempted to secure the best terms by dealing with a large number of foreign concerns, and have made it clear that every agreement and joint venture is to include training for Chinese workers.

In 1980 China signed contracts with three foreign oil companies for offshore exploration and joint production in the Bohai Gulf; Elf Aquitaine (France) surveyed another area in the Bohai Gulf; and Total (France) an area of the Gulf of Tonkin, off Hainan.[20] In September 1982 Atlantic Richfield (ARCO) of the United States began exploration near Hainan. In May 1983 a consortium led by British Petroleum was awarded five areas. In August 1983 two consortia, each headed by Occidental Petroleum of the United States, were awarded exploration areas, as was a partnership between Exxon and Royal Dutch Shell. In September 1983 the Japan National Oil Corporation received another area for exploration and a consortium headed by Japan's Idemitsu Oil Development Corporation was awarded an area.[21] Western equipment and service suppliers hope to follow the major oil companies. US producers of oil drilling "expendables" (piping, muds and chemicals, downhole gear, and replacement parts), which rely on conventional technologies, are reported to be ready to propose coproduction arrangements with Chinese counterparts.[22]

Appendix B provides data on transfers of various types of significant oil technology to China in 1982 and 1983.

(3) Hydropower

Although China's hydropower resources are the world's largest, only 3 percent have been developed and hydropower provides only 1 percent of China's energy. The current Five Year Plan calls for increased investment in hydropower and, in the long term, hydropower should provide a substantial share of China's energy. Development is difficult because the most promising sites are in remote areas of southwestern China, while dam sites closer to cities would flood valleys that are both densely populated and agriculturally productive.

In the construction of dams and generating stations, Chinese skills approach world standards and pride in self-reliance is reportedly strong in the Ministry of Water Conservancy and Electric Power.[23] Chinese dams, however, have generally taken longer to build and cost more than originally planned because of deficiencies in management and planning. Chinese turbines, while good, are not as effective as the most up-to-date foreign models. They provide about 10 percent less power and require more steel. Foreign technology would be useful in constructing very high-voltage transmission lines necessary to move electricity from dam sites to urban and industrial centers.[24] The most likely prospects for technology transfers would be in construction planning and management, construction machinery, turbine construction, and power transmission.

Hydroelectric power was the subject of one of the 17 Protocols on Exchanges in Science and Technology signed between the United States and the People's Republic of China in September 1979. Annex I to the Protocol, signed in March 1981, called for engineering assistance for several major projects by the US Army Corps of Engineers as well as training of Chinese specialists by the Tennessee Valley Authority and the Bonneville Power Administration.[25] Annex II, signed in February 1983, gives private American companies a major role in cooperative activities. US firms will have exclusive rights to bid for a feasibility study of the Tianshengqiao dam on the Hongshui River in Guangxi Zhuang Autonomous Region. The US Army Corps of Engineers will act as contracting agent for the Chinese. Annex II also envisages a series of seminars and exchanges of expert delegations.

Appendix C includes information on commercial transfers of hydropower technology to China in 1982 and 1983.

(4) Nuclear Power

In 1982 China made clear its intention to develop nuclear powerplants. The relatively developed areas along the coast and in the northeast provide 73 percent of the total industrial output, but have only 10 percent of the energy resources. This uneven distribution of energy resources coupled with the high cost and technical complexity of long distance power transmission from hydroelectric stations in the western mountains or pithead coal-fired thermal powerplants make nuclear power attractive.[26] The first nuclear powerplant, a 300-megawatt pressurized water reactor, is to be built at Qinshan, near Hangzhou Bay in Zhejiang Province, and is to be entirely Chinese designed and equipped.[27] This plant is sometimes referred to as the "728 Project," after the date, August 1972, when Premier Zhou Enlai approved the project.

In December 1982, it was announced that China's second nuclear plant was to be built in Guangdong Province using foreign technology. The plant, on the Daya Peninsula near Hong Kong, is to be equipped with two 900-megawatt pressurized water reactors.[28] The plans call for foreign financing and technology through a joint venture with the Hong Kong electric utility and sale of electricity to Hong Kong. Technology transfer appears to be one of the major purposes of this project. US export controls, imposed because of China's refusal to sign the nuclear test ban treaty or to agree to international inspection of imported nuclear technology, have rendered the export of reactors or nuclear power technology by United States firms nearly impossible. However, British and French firms have been eager to sell these items. News reports and commentary usually name the French firm Framatome as the likely source of the reactors and the British General Electric as the supplier of the power turbines.[29]

Serious negotiations with potential foreign suppliers continued throughout 1983, but by November no contracts had been signed. The total cost of the project would be around $5 billion. On 27 December 1982, the French Foreign Ministry confirmed that France and China had concluded an agreement for cooperation in nuclear power. Earlier reports from Beijing said the agreement covered research and development on pressurized water reactors of from 300 to 900 megawatts, as well as nuclear safety, sodium cooling technology, and the geology and processing of uranium ore.[30] China and Britain signed a memorandum of understanding for cooperation on the Daya reactors on 27 March 1983.[31] The memorandum made no specific commitments. During his May 1983 visit to China, French President Mitterrand announced that agreement in principle had been reached on the sale of four French nuclear reactors. The reactor deal would be worth at least $2 billion and would be the largest individual trade agreement ever signed with China.[32] Thus, Framatome offered its pressurized water technology to another country for the first time, in part because the technology, originally developed by the Westinghouse Corporation of the United States, is no longer regarded as subject to US export controls.[33] By the summer of 1983 there were still no firm agreements or contracts signed and financing for the project was in doubt. The fall in the price of coal on the world market and the uncertainty over Hong Kong's future reportedly made Hong Kong's utility company reluctant to invest in the Guangdong nuclear project, which would take at least 8 years to complete.[34]

There have been persistent reports that China would prefer US nuclear technology if it were available. American companies are eager to sell reactors to China. In January 1983, Westinghouse filed for an export license to sell two primary reactor coolant pumps, centrifugal charging pumps, and an in-core flux mapping system for the "entirely Chinese equipped" 300-megawatt Qinshan plant. The coolant pumps were denied export licensing in the absence of an agreement on nuclear cooperation between China and the United States.[35]

Throughout 1983 the transfer of nuclear technology was a major topic of discussions and negotiations between the Governments of China and the United States. In July a Chinese delegation visited Washington, and it was reported that considerable progress resulted. US law requires a bilateral agreement on inspection, reprocessing, and transfer of nuclear materials to third countries before American firms are permitted to sell equipment. The United States views China as a nuclear weapons state, like the Soviet Union, Britain, and France, when considering nuclear technology transfers. Sales to such states require inspection (the mode of which is unspecified) of only those facilities supplied by the United States, a condition that China is reported to find tolerable.[36] Furthermore, in October 1983 China's application to join the International Atomic Energy Agency was accepted.[37] This indicates China's willingness to accept the norms of the international nuclear energy trade, and thus increases its chances of importing nuclear technology from the United States and other countries. As long as these trends continue, a bilateral agreement between China and the United States is likely to be announced in 1984. Once that is done, finance and ability to assimilate the technology will become the major issues in China's import of nuclear energy technology.

Apart from commercial deals, China has a number of scientific exchange agreements that cover nuclear energy. Of these, the December 1982 Agreement with France (discussed above) is the most extensive. A 3 September 1981 agreement between the Japan Atomic Industrial Forum and China's 2d Ministry

of Machine Building (now the Ministry of Nuclear Industry) called for the exchange of experts and engineers, joint seminars and conferences, and technological exchange. Initially the focus was to be on the application of radioisotopes, but the possibility of extension to nuclear power was mentioned.[38] A protocol on cooperation in nuclear safety between China and the United States was signed on 17 October 1982. This does not appear to have resulted in major activity. Once the larger issue of a bilateral agreement on nuclear cooperation is resolved, there will probably be more extensive exchanges. On 9 December 1982, China's State Science and Technology Commission and the Federal Republic of Germany's Ministry of Research and Technology signed a protocol on cooperation in research on the peaceful use of nuclear power, as well as radio astronomy and aerolites.[39]

Appendix D presents data related to nuclear technology transfers to China in 1982 and 1983.

b. Heavy Industry

After decades of stressing the growth of heavy industry and "taking steel as the key link," current Chinese economic plans call for increased investment in energy and transportation (which account for 38.5 percent of planned investment during the Sixth Five Year Plan, 1981-85), and decreased investment in heavy industry.[40] Planned investment in heavy industry is described as "technical transformation," the goal being to upgrade existing facilites rather than to import or build complete new plants. Most major plants date from the 1950s or mid-1960s, and are technically obsolete. The situation is particularly severe in the older industrial centers such as Shanghai or Tianjin. The Nanjing University Journal recently asserted that 60 percent of the 28,000 varieties of machines manufactured by China's machine-building plants are outdated.[41] However, the cost of renovating all existing enterprises is tremendous. Another Chinese source cited an estimated cost of $240 billion,[42] about as much as the entire capital investment for the Sixth Five Year Plan.

The central authorities now will attempt to limit investment to key projects such as the Baoshan Steel Complex. Most imports of technology will consist of single items or processes, especially those intended to save energy and increase efficiency. Chinese managers are increasingly interested in licensing, and are likely to pay for technical advice and consulting services. The metallurgical, chemical, and transportation industries are examined as examples of heavy industry.

(1) Metallurgy

During most of the 1949-79 period the iron and steel sector had first priority for investment, with fully 24 percent of all funds spent on foreign technology during those years going to the metallurgical industry.[43] However, increasing the quantity of steel took precedence over improving quality, and the production of special types of steel and alloys was neglected. Steel, including that used for such military purposes as armor and gun barrels, had to be imported, usually from Japan. Iron and steel products have consistently been the largest single category of items imported from Japan and made up 50 percent of all Japanese imports in the first half of 1983.[44] According to Minister of Metallurgical Industry Li Dongye, the main priority for the iron and steel

industry is the production of alloy steel for use in ships, vehicles, oil drilling facilities, computers, earth satellites, and guided missiles.[45]

In March 1983 China's State Council decided to go ahead with the second stage of the Baoshan Steel Complex and to complete the first stage by September 1985. The first stage will include a harbor, blast furnace, and blooming mill. Most of the equipment will come from Japan and West Germany. Each year it is to produce 3 million tons of iron, 3 million tons of steel, and .5 million tons of seamless steel tube for use in the offshore oil industry.[46] Work on the second phase began in June 1983 with construction of a continuous cold-rolled strip mill which will produce 2.1 million tons of steel sheet per year. Equipment will be provided by a consortium of foreign companies headed by SMS-Schloemann Siemag of West Germany. Deliveries are to be made in 1985 and 1986. The other second phase facilities will include a blast furnace, a coking plant, a sintering unit, a continuous ingot casting unit, and a continuous hot-rolled strip mill.[47] On 12 September 1983 a technical cooperation contract between Japan's Nippon Steel Corporation and the China National Technical Import Corporation went into effect. Nippon Steel is to provide managerial and technical training for the Baoshan Complex. Japanese experts will be sent to Baoshan to provide on-the-spot technical instruction.[48]

Appendix E includes data on metallurgy technology transfers to China in 1982 and 1983.

(2) Chemicals

Over the past decade, the chemical industry has concentrated on increasing production of petrochemicals for the textile industry and fertilizers. During the 1970s a series of complete fertilizer and synthetic textile plants were purchased from the United States, Japan, and Western Europe. The purchase of a further series of large-scale petrochemical plants was announced in the late 1970s, but these were cancelled or postponed during the 1980 economic readjustment, when capital construction in the chemical industry was reduced by 30 percent.[49] Such purchases as have been made recently have primarily been of equipment and technology to upgrade existing facilities. Problems of the chemical industry were identified in 1981 as excessive energy comsumption, low quality, and lack of variety. As an example, although China produces huge quantities of dyestuff, specialized, high quality dyes must still be imported.[50] Most importation of technology in this area has been directed at these problems. In addition, some of the large-scale construction projects that were postponed or cancelled have recently been resumed.

Appendix F includes data on chemical technology transfers to China in 1982 and 1983.

(3) Transportation Equipment

The current Five Year Plan recognizes transportation as one of the "weak link" sectors requiring more investment. In no case does the improvement of China's transport system or transport equipment industry require highly sophisticated technology. The importation of proven techniques of manufacturing and traffic management will suffice.

The overwhelming volume of freight traffic in China is carried by internal waterways and railroads. China is second only to the Soviet Union in railroad traffic density. Since this performance has been achieved largely with steam traction and a communication and control system similar to that employed on railroads in the United States in the late 1920s, it is even more impressive. Although the rail system operates at maximum capacity, it cannot meet the demands on it. The most obvious example is the inability to transport coal out of Shanxi Province. Efficiency of the rail system can be improved by increasing the speed and density of traffic. To achieve this, more powerful diesel and electric engines are needed along with a modernized system of train dispatching and control.[51]

Road transport carries only a small percentage (about 3 percent) of China's freight volume. It is used mostly for short hauls and employs a fleet of Chinese-built trucks that are copies of obsolete Soviet and East European models. The most common type of truck in China is the Jiefang ["liberation"] model, a 4.5-ton general purpose truck, a copy of the Soviet ZIS-150, itself a copy of a late 1930s Ford. It consumes large quantities of fuel and, with its 90 or 110 horsepower engine, is unable to carry heavy loads. Domestic truck production has not been able to meet China's needs, either for numbers or types of trucks, and it is estimated that some 20 percent of the current truck inventory is imported, mostly from Japan, France, and Romania. The need is for heavy-duty and special-purpose trucks, and for an up-to-date general purpose truck which can be serially produced in large numbers.

As in other fields, China's primary need is for management skills. The problems are those of manufacturing engineering, quality control, inventory control, parts routing, component subcontracting, and the like. In this sector the drawbacks of China's self-reliant, compartmentalized and artisan-like manufacturing practices are apparent.[52] The main thrust of technology transfer has been purchase of special purpose vehicles and large-scale joint ventures or coproduction agreements for up-to-date, fuel efficient engines.

Appendix G provides data on significant transportation technology transfers to China in 1982 and 1983.

c. Electronics and Computers

(1) Electronics

The electronics industry demonstrates with exceptional clarity the achievements and the costs of China's policies of self-reliance and bureaucratic organization of production. Furthermore, electronics represents classic dual-use technology, with military as well as civilian applications. Hence, much electronic technology is subject to export controls which have hampered Chinese attempts to acquire state-of-the-art equipment and techniques, and have made controls on technology transfer a major international issue, especially with the United States.

On the one hand, Chinese achievements in electronics have been quite impressive. Beginning with a few electronic component factories imported from the Soviet Union in the late 1950s, China's electronics industry survived the cutoff of Soviet aid in 1960 and, by a combination of native development and

import of key technology from Japan and Western Europe, was able to manufacture integrated circuits by the early 1970s. During the 1970s China made fairly rapid progress in the manufacture of semiconductor devices and small integrated circuits. Most visitors to laboratories and research institutes have been favorably impressed by the level of work. Many sophisticated experimental and prototype devices have been produced.

On the other hand, progress in research has not been matched by progress in manufacturing. Electronics technology has made very rapid progress in the United States and Japan in the past decade and China remains at least a decade behind current capabilities. Many Chinese semiconductor devices are, as they admit, copies of Western ones, but the Chinese components are less reliable and more costly.[53] This is a consequence of problems in manufacturing and in quality control. Much electronics production is carried on in small plants, with great variations in the quality of the components produced. China's electronics industry employs over 1 million workers, has thousands of enterprises, and scores of research institutes. Arguing for consolidation of production, Renmin Ribao called in May 1981 for "breaking through the restraint of 'ownership by departments' and 'ownership by localities'" as one way to increase quality.[54] Quality control and production of components in large volume, rather than small batches, are pervasive problems, in part because production of semiconductors and integrated circuits demands inputs of very pure ingredients in a carefully controlled environment, and in part because careful testing of all components is necessary. Foreign experts see automation as the only solution to the problems of poor quality and low rates of production. Differences between Chinese standards and world standards cause incompatibility with imported equipment. For example, under Chinese standards (originally based on Soviet standards) the distance between integrated circuit sockets is 1.25 millimeters, while under international standards it is 1.27 millimeters. Also, it is a common practice for factories to produce their own meters and test equipment resulting in nonstandard meters and test equipment.[55]

Problems in basic manufacturing practice and scarcity of purified water and air, as well as automated testing equipment, mean that no quick solution is possible. China has been importing a wide range of electronics technology, but has recently concentrated on production lines for such consumer goods as color television sets. It is also attempting to import production equipment for such advanced devices as large-scale integrated circuits. These attempts have sometimes failed or been delayed because of US and COCOM export controls.

Two major projects are characteristic of China's recent imports of electronics technology. The first is the attempt to establish a plant to produce semiconductor components for color televisions at the Jiangnan Radio Factory in Wuxi, Jiangsu Province. The plant will include a (silicon) wafer fabricating line, with all equipment imported from the United States. By mid-1982, 50 contracts had been signed with 42 companies and all but four of the contracts had been approved for export by COCOM and the US Department of Commerce. The remaining four sales (a sputtering system, plasma etching machine, mask inspection system, and a computer-assisted design, computer-assisted manufacturing (CAD/CAM) system for the circuit chips) finally were approved for export in August 1983, after the United States announced a liberalization of the controls on export of technology to China. At full capacity, the plant will produce wafers for 24 million integrated circuits per year, with a line width capacity of about 8 microns. The circuits will eventually be used in color

televisions manufactured at a plant built by Hitachi. The Chinese agreed to permit Kayex Hamco, an American company which sold one crystal puller, to inspect crystal pullers at the Wuxi plant every 6 months and to monitor the facility's records to verify to the US Government that silicon material was being used for its stated purpose and not diverted to other industries. The total cost of the equipment is $8 million.[56] A similar arrangement also has been reached to supply approximately $10 million worth of equipment for color television components to the Beijing Electron Tube Factory. Export approval was granted in September 1983.[57] The significance in both cases lies not in Chinese production of color television sets, but in the technology for mass production of small integrated circuits.

On 30 July 1983, the China National Post and Communications Industry Corporation signed an agreement with the Belgian Bell Telephone Manufacturing Company, a subsidiary of International Telephone and Telegraph Corporation (ITT) of the United States, for the sale and eventual joint production in China of highly sophisticated, microprocessor-based digital switching systems for telephones. With an initial contract value of $250 million, this is the largest high technology transaction in China's foreign trade history. The contract sets up a joint venture and calls for the phased transfer of technology. During the first phase, 100,000 lines will be imported from Belgium and used to upgrade and extend the telephone networks of Beijing, Shanghai, and Tianjin. Later in phase one, the joint venture will begin to assemble components imported from Belgium at a renovated plant in Shanghai. US export approval for the first phase is said to be assured. The second phase calls for all technology for manufacturing to be transfered. By 1988 the joint venture is scheduled to be producing all of the parts for 300,000 lines annually. This will include assembly of the digital switch as well as the testing, packaging, and wafer fabrication of the 8086 microprocessor, the heart of the system. Although export approval of phase two is expected, it is by no means certain. This contract is significant both as an example of the level of technology the United States is willing to permit to be exported to China and as a precedent for other technology transfer arrangements.[58]

Appendix H presents data on electronics transfers to China in 1982 and 1983.

(2) Computers

China announced in late 1983 that by the end of 1981 it had in use 3,945 "small, medium, and large" computers and more than 10,000 microcomputers. In 1982 the country produced 241 small, medium, and large computers and 7,208 microcomputers. About $100 million worth of computers have been imported every year since 1978. There are some 100,000 people in China engaged in computer research, production, teaching or servicing. Colleges and universities graduate 2,500 computer technicians each year. They work in 10 research institutes, 30 manufacturing units, 30 applications, development and servicing units, and more than 90 colleges and universities. Twenty-two of China's 29 provinces, autonomous regions, and independent municipalities have established computer centers, and most of the industrial ministries have also established their own computer centers and research institutes of applied technology. The Leading Group for Developing Computers and Large-scale Integrated Circuits of the State Council has announced that computers are now being used to direct freight traffic to the 6,000 railway stations throughout the country, thus helping to save nearly 1,000 freight cars every day.[59]

China produces more than 150 models of computers, but they suffer from a lack of standardization, which severely inhibits widespread use and the development of peripherals.[60] Furthermore, Chinese computers are costly and lacking in reliability. According to the report of an American delegation of software specialists who visited China in mid-1982, Chinese factories were able to produce only a 4K RAM chip. Chinese-made microcomputers are based on the Intel Corporation's 8080 model, but do not contain an 8080 integrated circuit. They have a wired board equivalent, but the error rate in hand-wiring the board contributes to the high cost and low reliability of the Chinese machine. The American delegation stated that for the next 20 years the Chinese would be able to import microcomputers more cheaply than to build them.[61] Apparently some producers of Chinese computers have responded to this situation by importing foreign components and assembling them. A Chinese computer specialist writing on microcomputer development in China reacted to this trend by stating:

> Some electronic industrial plants (and a small handful of universities and research institutes) have been importing micromodules, assembling them into single board processors and complete machines, and reaping enormous profits by selling them at prices five to ten times the original cost. This is detrimental to the domestic national industries. . . .[62]

Another Chinese article on the computer industry claimed that, "Over the past few years, China's microcomputer output has dropped markedly because of the powerful impact of imported microcomputers."[63]

Discussions within China about whether to protect the domestic industry or to import cheaper foreign goods are frequent. Regardless of whether China produces computers domestically or imports cheaper foreign models, efforts to extend the use of computers will be hindered by problems of peripherals, software, and technical support. Chinese research institutes have emphasized hardware rather than software, leaving China's computer technology about 10 years behind the United States in terms of hardware (which is produced in prototype or small quantities), 20 years behind in software, and 25 years behind in fabrication and testing.[64] Application of computers also has lagged behind their development. In part this is because of language problems. There is no commonly accepted method of programming or processing with Chinese characters. Although several research institutes, like their counterparts in Hong Kong, Taiwan, and Japan, have devised various methods for inputting and outputting Chinese characters, they do not appear to have any way of processing the stored characters, that is of doing sorts, merges, or comparisons. Most programming is done in ALGOL-60, with FORTRAN used for some applications. Data is usually entered with paper or magnetic tapes.[65]

A 1982 article by a researcher at the Chinese Academy of Science's Institute of Computer Technology called for putting priority on the application of computers. After summing up Chinese computers as "unreliable, incomplete in configuration, difficult to use and maintain, and made in a wide range of varieties," he argued for recognition of computer applications as an independent field of study.

> The several hundred large and medium sized computers and nearly 10,000 microcomputers which we have imported to date have not been effectively used . . . the main current problem

> is not the lack of large-scale computer production but inability to utilize small lots of computers. We lack software personnel, applications research is carried on by individual organizations, and there are very few organizations which serve computer users.

He pointed out further that:

> Improving the quality of computer applications will rely more on people's mental labor and less on the industrial quality of materials and processes, and will require smaller investments. Giving priority to the development of computer applications will take advantage of strong points and avoid weak points, will yield results rather quickly, and in addition will provide a motive force for the development of the computer production industry.

He also noted that the prices of components and large-scale integrated circuits were certain to drop on the international market, and urged importing them to assemble into cheap microcomputers, while working on the development of peripherals, which are much more expensive than central processing units.[66]

At an April 1983 conference on computers and integrated circuits, State Councilor Fang Yi, a major figure in China's science policy formulation, proposed that research work should focus on medium- and small-sized computers, particularly microcomputers; that a software industry should be established in the quickest time possible; and that international exchange, cooperation, and trade contacts should be strengthened and expanded.[67] If this policy is in fact pursued, then the importation of technology to manufacture peripheral equipment, and training in computer applications and software may well be more significant for China's efforts to catch up with foreign nations than the importation of a few more, or slightly larger or faster computers.

(3) Software Development

In January 1982, Nippon Electric Corporation and the China Computer Technical Services Corporation (established in 1980 to meet needs for software development, operator training, and routine maintenance) opened a joint Sino-Japanese Software Center to train programmers and systems analysts, and offer such services as software system design. In the summer of 1982 Fujitsu Ltd. and Qinghua University agreed to jointly develop software, and are working on a FORTRAN program execution profile analyzer--a system used to develop and test computer programs. Japan Computer Engineering has signed an agreement with China's Bureau of National Computer Industry for Japan to provide training and software designs to Chinese programmers. The Chinese will code, debug, and test the programs, which will then be exported to Japan for use in Japan Computer Engineering's "Star 10" desktop computer.[68]

Some training and software services are provided by the service centers that foreign computer manufacturers have opened in China. Under an agreement with China Computer Technical Services Center, signed in early 1983, Sperry Univac of the United States was to open a service center. The center was to use a Sperry-owned 1100/60 mainframe computer to provide hardware and software maintenance and to train Chinese personnel. Another American company, Hewlett

Packard, has been operating such a center since November 1981.[69] Under contracts signed with the China National Technical Import Corporation in December 1980 and June 1983, the Honeywell Corporation of the United States has two service centers for Honeywell computers and instruments, in Shanghai and in Sichuan Province. Honeywell also has agreed with China's State Administration of the Computer Industry to transfer technology and training for final system configuration and testing and for maintenance of hardware and software. Honeywell has sold several DPS-8 test cells. These are configurations of equipment with a wide variety of peripherals and input/output devices which permit engineers to trace any problems in a new central processing unit that is being tested. In a similar manner, new peripherals can be plugged into the system and tested. IBM (Japan) also has a service center in Beijing for its computers. Foreign companies, however, usually regard service centers in China as operations on which they lose money, and participate in establishing them (usually as a joint venture of some type) only in the hopes of increasing sales of their products.[70]

Appendix I presents a list of computer technology transfers to China in 1982 and 1983.

d. Aviation and Avionics

China's aircraft industry was set up with Soviet assistance in the 1950s, and was devoted to producing copies or slight modifications of Soviet aircraft of the 1940s and 1950s. While the substantial technology transfer program of the 1950s was successful in its immediate goals, China's attempts to produce indigenous and more up-to-date aircraft have not been notably successful. The most impressive achievement so far has been the YUN-10, a four-engine jet transport that first flew in late 1980. It closely resembles the Boeing-707 (a plane developed in the 1960s), but is somewhat smaller. It is powered by Pratt and Whitney JT3D-7 engines, the same engines used in the Boeing-707.[71] As with many projects in China, the YUN-10 has been developed as a prototype. This doubtless increased the skills of the engineers and fabricators who made it; but the plane has not gone into serial production, and may never do so.

The greatest problems are with jet engine design and production. The next most serious problems are with the special alloys and composite materials used in airframe production.[72] Chinese avionics are generally obsolete. Until very recently most civil airliners flew only in good weather, and even the CPLA Air Force operated for the most part only in daylight and clear weather.

The Chinese aircraft industry is primarily devoted to military aircraft. A 1982 press account claimed that nonmilitary items accounted for 26 percent of the total output of the aviation industry, up from only 7.6 percent 3 years before.[73] The high proportion of production devoted to military use is in part a consequence of China's policy of importing civil airliners rather than attempting to manufacture them. Since the purchase of the British Viscount turboprop transports in 1963 and 1964, all of China's large airliners have been imported. The most recent imports have come from Boeing, which provided 10 Boeing-707s in 1972, and 5 Boeing-747s between 1980 and 1982.

The major attempt to advance China's jet engine manufacturing skills was the Spey engine project. In December 1975 Rolls-Royce of the United Kingdom agreed to license production of its RB168-25R Spey Mark 202M afterburning turbofan engine at the aircraft factory at Xi'an, Shanxi Province. The engine's

design dates from the early 1960s, but it still represented a considerable advance over the Soviet jet engines that power China's military aircraft. The first two engines were trial produced at Xi'an in late 1979, while over 700 Chinese technicians were being trained at the Rolls-Royce factory in England.[74] When the project began it was not clear to what use the engine would be put, though there was much speculation about using it in a new Chinese fighter or a Chinese version of the MiG-21, the F-7. However, the engine has apparently never gone into production, and the Chinese have not discussed the matter. The lack of a suitable airframe and serious quality problems in the engines produced have been suggested as reasons.[75]

The most successful transfer of aviation technology has been the coproduction of helicopters. In July 1980, China National Aerospace Technology Import and Export Corporation (CATIC) signed a contract with Aerospatiale of France for joint production of 50 Dauphin 2SA 375N helicopters. The airframes are produced at a helicopter factory in Harbin and the engines at Zhuzhou, Hunan. The Chinese are expected to reach the stage of complete fabrication of the helicopters by mid-1985. Production is expected to continue under license for an additional 3 to 4 years, with certain materials such as alloys for the engines and epoxies for the rotors still imported from France.[76]

China has been reported to be seeking technology for advanced Pratt and Whitney jet engines for military aircraft, but no decision on such a sale has been announced.[77] During 1982 and 1983, no major transfers were reported, apart from additional civil airliners.

China's air traffic control system is being modernized with equipment imported from France and the United States. A long-range radar system for air traffic control ordered from Thomson CSF of France in 1977 was expected to go into service in summer 1983. It is to provide a corridor of primary and secondary (beacon) radar coverage between Beijing and Shanghai. It can also serve China's air defense system. The network consists of six long-range L-band Thomson LP-23 radars, and three shorter range S-band Thomson TA-105 radars, two at military airfields near Beijing and one at a military airfield near Shanghai. An automated air traffic control system imported from the AIL Division of the Eaton Corporation of the United States became operational at Guangzhou Airport in early 1983. The automated TPX-42 has capabilities approaching those of the automated radar terminal system (ARTS-3) installed at 62 airports in the United States. China has about 18 VOR (VHF Omnidirectional radio range) stations to guide civil airliners. Some of the stations are also equipped with DME (distance measuring equipment). Thomson is believed to have supplied most of China's VOR facilities. As of June 1983 China had taken delivery of 12 DME stations from Northrop's Wilcox Electric Division, and had four more on order. Wilcox had also delivered six instrument landing systems to China, for use in the airports at Xi'an, Chengdu, Guangzhou, Xiamen, Guilin, and Shenyang.[78] Beijing Airport has two older instrument landing systems produced by the British firm, Standard Telephone and Cable, Ltd.[79]

## Appendix A

### Import of Coal Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| 18 Feb 82 | "Japan's Organ for the Consolidated Development of New Energy Resources"/Japan | General Corporation for Exploitation of Coal Resources | Liuzhang Mining Area, Huainan Coalfields, Anhui Province | digital seismological surveying equipment; specialists in geology and geophysical survey | unknown | -- | Xinhua, 18 February 1982 in FBIS/China, 23 February 1982, p. D1 |
| 27 Apr 82 | Fluor Mining and Metals Corp., Redwood City, California/ United States | China National Coal Development Corp. | Fushun West Open-Pit Mine, Liaoning Province | engineering and design services to modernize the mine | $50 million | -- | World Coal (New York), July/August 1982, p. 9 |
| 12 May 82 | Romania Bucharest Co./ Romania | China National Technical Import Corp. | Coking Coal Mine and Preparation Plant, Huoxian, Shanxi Province | design of plant and mine | unknown | -- | China Business Review (Washington), July/ August 1982, p. 50 |
| 24 May 82 | Minequip/France | unknown | Mine in Yanzhou Coalfield, Shandong Province | mining equipment | $45.8 million | Financed through a 7.5 percent credit from the French Government | Asian Wall Street Journal (Hong Kong), 24 May 1982, p. 9 |
| Jun 82 | Joy Manufacturing Co./ United States; Denver Equipment Co./United States | unknown | Xiqu Coal Mine, Shanxi Province | indirect heat exchange dryer for a 3 million tons/year coal preparation plant | unknown | Will be the world's largest dryer of this type | Sino-British Trade (London), August 1982, p. 13 |
| Aug 82 | Consortium of European companies | China Southwest Energy Resources United Development Corp. | Regional coal development project | -- | unknown | -- | China Business Review (Washington), November/December 1982, p. 46 |
| Aug 82 | Salzgitter/Federal Republic of Germany | China Southwest Energy Resources United Development Corp. | Zhanjiang Port, Guangdong Province | improve port facilities | $330 million | -- | China Business Review (Washington), November/December 1982, p. 46 |
| Aug 82 | Althom-Atlantique/ France | China Southwest Energy Resources United Development Corp. | 3,000-megawatt powerplant | build powerplant | $1.5 billion | -- | China Business Review (Washington), November/December 1982, p. 46 |

Import of Coal Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Aug 82 | Focoex/Spain | China Southwest Energy Resources United Development Corp. | coal mine | construct the mine | $2.3 billion | -- | China Business Review (Washington), November/December 1982, p. 46 |
| Aug 82 | Asec/Belgium | China Southwest Energy Resources United Development Corp. | railway between Liupashi and Zhanjiang | railway development | unknown | -- | China Business Review (Washington, November/December 1982, p. 46 |
| 1 Sep 82 | Warman International/ Australia | China Southwest Energy Resources United Development Corp. | Shijiazhuang Pump Works, Hebei Province | license production of Warman slurry pumps; Chinese technical delegation studies manufacture of pumps in Australia | unknown | -- | World Coal (New York), September/October 1982, p. 22 |
| 29 Oct 82 | Shell Coal International Ltd./United Kingdom | China National Coal Development Corp. | Jining No. 2 Coal Mine, Shandong | feasibility study for development of the mine | unknown | -- | Xinhua, 29 October 1982, in FBIS/China, 5 November 1982, p. G1 |
| Nov 82 | Mitsui and Toko Bussan Cos./Japan | Ministry of Coal Industry | unknown | variety of dumpers, stackers, loaders, conveyors, and other equipment to transport coal from inland mines | unknown | -- | Sino-British Trade (London), February 1983, p. 15 |
| Jan 83 | Magco Ltd., of Babcock Engineering Group/ United Kingdom | unknown | unknown | two rotating screens for separating fine coal from damp sticky lumps | $200,000 | In 1979 Babcock contracted to supply coal pulverising mills and technology for conversion of power stations from oil to coal | China Trade and Economic Newsletter (London), February 1983, p. 15 |
| Jan 83 | PHB Weserhutte AG/ Federal Republic of Germany | China Machine Building International Corp. | Shenyang Mining Machine Works | know-how for manufacture of high-capacity belt conveyers | unknown | -- | China Business Review (Washington), May/June 1983, p. 55 |

Import of Coal Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Feb 83 | Bechtel Corp./United States | China National Coal Development Corp. | Junggar Coalfield, Nei Mongol Autonomous Region | feasibility study for open-cut mine and an associated 800-kilometer coal slurry pipeline | unknown | -- | Sino-British Trade (London), April 1983, p. 15 |
| Apr 83 | Fluor Corp./United States | China National Coal Development Corp. | unknown | cooperation in construction of a 960 kilometer coal slurry pipeline, from Changzhi in Shanxi Province to Nantong in Jiangsu Province | unknown | -- | Xinhua, 11 April 1983, in FBIS/China, 12 April 1983, p. B1 |
| Apr 83 | New Energy Development Organization, Mitsui Engineering and Shipbuilding Co./Japan | unknown | research project on coal liquefaction | continuous coal liquefaction unit, with a daily processing capacity of 100 kilograms | unknown | China's first such unit, for a pilot project | Sino-British Trade (London), May 1983, p. 5 |
| Apr 83 | Occidental Petroleum Corp./United States | China National Coal Development Corp. | Pingshuo (also known as Antaibao) Open-Pit Mine, Shanxi Province | interim agreement for Occidental to develop the mine, for which it had previously made a feasibility study | Occidental to invest $230 million over 4 years | By August 1983, the deal, which would have been one of the largest joint ventures in China, was in doubt; the world price of coal dropped from $52 a ton to $40 a ton, making Occidental reluctant to go ahead with the project without an increased share of the coal, or reduced costs to itself | Wall Street Journal (New York), 10 August 1983, p. 28 |

Import of Coal Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| 20 Jun 83 | Fluor Corp./United States | China National Coal Development Corp. | Shahuer Lignite Mining Area and No. 1 Open-Pit Mine, Huolinhe mining area, Nei Mongol Autonomous Region | contract for consultation on overall plan and design of the mines; Fluor's work to include basic mine design, a coal preparation plant, surface facilities, materials handling, and a waste-water sewage treatment plant | unknown | -- | Xinhua, 20 June 1983, in FBIS/China, 22 June 1983, p. B1; Asian Wall Street Journal (Hong Kong), 29 August 1983, p. 3 |
| Jun 83 | Thyssen Reinstahl Technik Co./Federal Republic of Germany | China National Coal Development Corp. | Donghuantuo No. 2 Coal Mine, Tangshan, Hebei Province | technical expertise and equipment for construction of the mine | unknown | -- | Sino-British Trade (London), August 1983 p. 12 |
| Jun 83 | Fairchild Industries/ United States | Techimport Corp. | Xishan Mining Bureau, Shanxi Province | two complete sets of equipment for thin-seam mining | unknown | -- | Sino-British Trade (London), August 1983 p. 12 |
| Sep 83 | Anderson Strathclyde Ltd./United Kingdom | China National Technical Import Corp.; China National Coal Development Corp. | unknown | long-term technology transfer agreement; Anderson Strathclyde's range of coal shearers, sophisticated coal cutting equipment for long-wall mining, will be produced in China | $21 million | In previous agreements, Anderson Strathclyde sold long-wall equipment worth $3.56 million in March 1983, and 18 coal shearers and 6 coal face conveyers worth $20.9 million in June 1983 | China Business and Trade (Washington), October 1983, p. 2 |

Appendix B

Import of Oil Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Jan 82 | Baker Marine Corp./ United States | unknown | Jiangnan Shipyard, Shanghai | BMC-1600 semi-submersible drilling platform | unknown | Baker agreed to provide blueprints, material, and equipment; China has been producing jack-up rigs since 1972, under a licensing agreement with the United States' Datar Marine Corp. and Bethlehem Steel | Sino-British Trade (London), April 1982, p. 14 |
| Spring 82 | Control Data Corp./ United States | China National Oil and Gas Exploration and Development Corp. | unknown | CYBER 730 mainframe computer | unknown | Control data has sold nine CYBER 720s to China since 1978 (eight to the Ministry of Petroleum and one to China National Oil and Gas Exploration and Development Corp.; an export license for a CYBER 750 was pending in March 1983 | China Business Review (Washington), March/April 1983, p. 47 |
| Mar 82 | Ingalls Corp./ United States | China Shipbuilding Industries Corp. | unknown | L-780 Mod 2 jack-up rigs | unknown | These rigs are intended for sale to foreign oil companies operating off the coast of China | Seatrade (New York), March 1982, p. 19 |
| Mar 82 | Wah-Chang Co./ Singapore | China Shipbuilding Industries Corp. | unknown | Bethlehem Steel semisubmersible rigs | unknown | Second one built in China | Seatrade (New York), March 1982, p. 19 |
| Apr 82 | Hughes Tool/United States | unknown | Jianghan Factory, Hubei Province | equipment and know-how to manufacture rock drilling bits | unknown | Hughes agreement with China had originally been announced in June 1980; the Chinese were to have built a new factory in Chengdu, Sichuan Province to manufacture the rock bits | Offshore (Tulsa), 5 June 1980, p. 119 |

Import of Oil Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| May 82 | Japan National Oil Corp./Japan | China's Ministry of Geology and Minerals | unknown | survey of northern Ordos Basin for 5 years beginning in June 1982 | unknown | -- | Sino-British Trade (London), June 1982, p. 13 |
| May 82 | Western Geophysical Co./United States | unknown | unknown | IBM 3033 with petroleum industry applications | unknown | Computer to be used under contract in China for oil exploration | China Business Review (Washington), March/April 1983, p. 47 |
| May 82 | Perkin Elmer/United States | China National Oil and Gas Exploration and Development Corp. | unknown | five 3220 super minicomputers | unknown | To be used to process well-logging data at four on-shore oil fields | China Business Review (Washington), March/April 1983, p. 47 |
| Jul 82 | Christensen Corp./United States | China National Oil and Gas Exploration and Development Corp. | center at Dagang, near Tianjin | oilfield machinery sales and service | unknown | -- | China Business Review (Washington), November/December 1982, p. 47 |
| 14 Sep 82 | Geophysical Co./Norway | China National Offshore Oil Corp. | joint venture company | geophysical and seismic survey services to foreign oil companies planning to drill off the Chinese coast | unknown | -- | China Daily (Beijing), 14 September 1982, p. 1 |
| Nov 82 | Vetco Offshore, Inc., a subsidiary of Combustion Engineering/United States | China State Shipbuilding Corp., Shanghai | Kantan III, a semisubmersible drilling rig | complete oil drilling system | unknown | -- | China Business Review (Washington), January/February 1983, p. 52 |
| Nov 82 | PMC Corp./United States | unknown | Baotou Steel Mill | 10 oil pipe coupling machines | $2 million | | China Business Review (Washington), March/April 1983, p. 47 |

Import of Oil Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Dec 82 | Oceaneering/United States | unknown | China Nanhai Oil Joint Services Corp. | train Chinese divers and divers from oil companies drilling in Chinese waters | unknown | -- | China Business Review (Washington), March/April 1983, p. 47 |
| 19 Jan 83 | Brown and Root Co./United States | China National Offshore Platform Engineering Corp. | joint venture | services including design and supervision of marine engineering projects and purchase and installation of equipment | unknown | -- | Xinhua, 19 January 1983, in FBIS/China, 20 January 1983, p. B4 |
| Mar 83 | Napco Europe Ltd./United Kingdom | China Petroleum | Jianghan Rock Bit Factory | three surface finishing machines | $750,000 | -- | Sino-British Trade (London), April 1983, p. 15 |
| 15 Mar 83 | Taylor Diving Co./United States | China Ocean Engineering Services, Ltd. | unknown | training the first group of divers in the use of a saturation diving system | unknown | Taylor to provide instructors for the 5-month training course, and graduates of the program are to work together with Taylor personnel in the offshore oil program | China Daily (Beijing), 2 March 1983, p. 2 |
| 17 Mar 83 | Baker Marine Corp., Texas/United States | China National Offshore Oil Corp. | joint venture | build a semi-submersible drilling rig at Shanghai's Jiangnan Shipyard | unknown | Rig will be capable of working in 1,600 feet of water and is expected to be completed in 1985; Baker has already had two jack-up rigs built at Dalian | Wall Street Journal (New York), 17 March 1983, p. 31 |
| Jun 83 | Wah-Chang International Group/Singapore; Reading and Bates Drilling Co., Houston/United States | China National Offshore Oil Corp. | unknown | modification and upgrading of two Chinese-built jack-up drilling rigs | $6 million | Will enable the rigs to drill in deeper water | China Trade Report (Hong Kong), July 1983, p. 4 |

Import of Oil Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Jun 83 | Maxiran Corp./ United States | China National Offshore Oil Corp., South Seas Branch West | unknown | navigational equipment for ships and oil rigs | $2 million | -- | Sino-British Trade (London), July 1983 p. 15 |
| Jul 83 | Pipco (Offshore)/ United Kingdom | China National Offshore Oil Corp. | unknown | training in Guangzhou; courses are to cover geology, oil exploration, rigs and platforms, supply bases, helicopters, communications, downhole technology, production, safety, and contracts | unknown | -- | Sino-British Trade (London), August 19 p. 13 |
| 14 Jul 83 | Racal Survey Ltd./ United Kingdom | China National Offshore Oil Corp. | unknown | set up two joint venture survey companies, one for the Bohai Gulf and one for the South China Sea; the companies will be equipped with advanced radio positioning devices and be responsible for training Chinese personnel | unknown | -- | China Daily (Beijing) 15 July 1983, p. 2 |
| Aug 83 | National Supply, a subsidiary of Aramco/ | China National Machinery and Equipment Import and Export Corp. | Lanzhou Petroleum and Chemical Machinery Works | technology for building components on offshore electric drilling rigs | unknown | -- | Sino-British Trade (London), September 1983, p. 14 |

Import of Oil Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Aug 83 | McEvoy Oilfield Equipment Corp./ United States | unknown | Shanghai No. 2 Petroleum Machinery Works | well head valve technology | unknown | -- | Sino-British Trade (London), September 1983, p. 14 |
| 8 Oct 83 | Geoservices Co./ France | China National Offshore Oil Corp. | joint venture, based at Tanggu on Bohai Bay | mud slurry logging services to oil companies | unknown | French company will provide the joint venture with one new computer, three used computers, and relevant instruments and meters | China Daily (Beijing), 10 October 1983, p. 2 |

## Appendix C

Import of Hydropower Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Apr 82 | General Electric/ United States | unknown | 500-kilovolt transmission line in North China | advanced solid-state relaying and signaling equipment | unknown | -- | China Business Review (Washington), July/August 1982, p. 51 |
| Aug 82 | Sievarts Kabelverk/ Sweden | unknown | Shenyang (Liaoning) Cable Works | production equipment for cross-lined polyethylene power cables | $12.9 million | -- | China Business Review (Washington), November/December 1982, p. 48 |
| Nov 82 | Intermediate Technology Industrial Services, Evans Engineering, and GP Electronics/United Kingdom | unknown | unknown | electronic load devices to reduce the cost of building small hydroelectric power stations | unknown | -- | Sino-British Trade (London), January 1983, p. 14 |
| 1 Mar 83 | Allis Chalmers Corp./ United States | unknown | unknown | manufacture of electric power-generating equipment and other machines | unknown | -- | Xinhua, 1 March 1983, in FBIS/China, 2 March 1983, p. B2 |
| 7 Apr 83 | Hazra Engineering Corp./United States | unknown | Tianshengqiao (Guangxi) power project | advise on the design | $4 million | -- | China Business Review (Washington), July/August 1983, p. 50 |

## Appendix D

Import of Metallurgy Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Summer 82 | Officine Meccaniche Danieli/Italy | unknown | Wuyang Steel Works in Guangzhou | services for the renovation of a small rolling mill | $2 to $3 million | -- | China Business Review (Washington), September/October 1982, p. 57 |
| Aug 82 | Mass-Global Corp./United States | Guangzhou Industrial Development Corp. | unknown | aluminum extruding plant and anodizing facility | $2 million | -- | China Business Review (Washington), November/December 1982, p. 47 |
| Sep 82 | Nippon Light Metal Corp./Japan | unknown | unknown | computer-controlled aluminum smelting plant with an annual capacity of 80,000 tons | $115 million | When fully operational the plant will increase China's aluminum production by 20 percent | Sino-British Trade (London), September 1982, p. 13 |
| Nov 82 | Thermo Electron Corp./United States | unknown | Jiang Han Rock Drill Bit Plant | design, deliver, and erect heat treating furnaces to harden steel | unknown | -- | Sino-British Trade (London), January 1983, p. 15 |
| Nov 82 | Japan Steel Works Ltd./Japan | China Machine Building International Corp. | unknown | license technology for the manufacture of large-sized steel castings and forgings | unknown | Two Chinese factories are to be remodelled | China Business Review (Washington), January/February 1983, p. 53 |
| Jun 83 | Sweden's Scandinavian Lancers Corp./Sweden | Liaoning Provincial Metallurgical Products Import and Export Corp. | Dalian Steel Plant, Fushun Steel Plant, General Machine Repair Works of the Anshan Iron and Steel Plant, and the Xinfu Steel Plant | four sets of blowing equipment for steel smelting | unknown | Payment for the equipment will be in screw-steel products manufactured in those plants | China Trade Report (Hong Kong), July 1983, p. 3 |
| Oct 83 | General Electric Co./United States | unknown | Harbin Cable Factory, in Heilongjiang Province | China's first oxygen-free copper production line | unknown | All technicians, maintenance workers, and equipment operators received training in the United States or Japan | China Trade and Economic Newsletter (London), October 1983, p. 3 |

## Appendix E

### Import of Chemical Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Feb and Mar 82 | Toko Bussan Co./ Japan | China National Technical Import Corp., the Shanghai General Foreign Trade Corp., and the Tianjin Equipment Import and Export Corp. | unknown | joint manufacture of three polyester fiber plants | $14.9 million | -- | Sino-British Trade (London), April 1982, p. 14 |
| Mar 82 | Marubeni Corp., and the Niigata Engineering Corp./Japan | unknown | unknown | acrylonitrile butadiene styrene resin plant to be built at Lanzhou | $16.3 million | The plant, due to be completed in 1984, will have an annual capacity of 10,000 tons, and will use Mitsubishi Rayon and Nippon Zeon technology | Sino-British Trade (London), May 1982, p. 13 |
| Mar 82 | Dunlop Holdings Ltd./United Kingdom | unknown | Guangzhou Rubber Bureau's manufacturing facilities | agreement to help modernize | unknown | -- | China Business Review (Washington), July/ August 1982, p. 50; Sino-British Trade (London), February 1983, p. 14 |
| Mar 82 | Dunlop Holdings Ltd./United Kingdom | unknown | Guangzhou Tire Factory | technology and equipment for the production of truck tires | unknown | -- | China Business Review (Washington), July/ August 1982, p. 50; Sino-British Trade (London), February 1983, p. 14 |
| Apr 82 | Japan and Federal Republic of Germany | unknown | Zhejiang Oil Refinery, the Urumqi (Xinjiang) Petrochemical Plant, the Shanxi Chemical Fertilizer Plant, and the Dongfang Chemical Works in Beijing | construction of four large chemical fertilizer projects suspended in 1980 | unknown | -- | Sino-British Trade (London), May 1982, p. 6 |

Import of Chemical Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| 21 Jun 82 | Mariletta Chemicals Corp./United States | unknown | Dalian Dye Factory | joint venture which is expected to produce 10,000 tons of liquid sulphur dyes per year | unknown | -- | China Business Review (Washington), September/October 1982, p. 55 |
| Oct 82 | Eurotecnica SPA/ Italy, on a patent from Universal Oil Products | unknown | China's largest alkyl-benzene plant, Nanjing | equipment | unknown | It will produce 500,000 tons a year of this raw material for detergent, satisfying China's total needs | Sino-British Trade (London), November 1982, p. 5 |
| Nov 82 | Engineering Science Corp./United States and Japan's C. Itoh & Co. and Kubota Ltd./Japan | Yanshan Petrochemical Corp. | Yanshan complex in Beijing | engineering, procurement, and construction management services to upgrade the air and water pollution control equipment | unknown | -- | China Business Review (Washington), January/February 1983, p. 51 |
| Dec 82 | Italy (unspecified firm) | unknown | East China Electronic Tubes Factory in Nanjing | production line for getter, a substance used to remove gaseous residue from vacuum tubes | unknown | -- | Sino-British Trade (London), July 1983, p. 14 |
| Apr 83 | | | | | | It was announced in April 1983 that work on eight major chemical plants has been resumed, after being cancelled in 1980 | |
| Apr 83 | Ube Industries Ltd./ Japan | unknown | 300,000-ton per year ammonia factory near Ningpo in Zhejiang Province | machines | unknown | -- | Sino-British Trade (London), July 1983, p. 14 |
| Apr 83 | Ube Industries Ltd./ Japan | unknown | unknown | ammonia plant at Urumqi | unknown | -- | Sino-British Trade (London), July 1983, p. 14 |

Import of Chemical Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Apr 83 | Japan (unspecified company) | unknown | Dongfang Chemical Works, Beijing | acrylic ester plant | unknown | To go into operation in 1984 | Sino-British Trade (London), July 1983, p. 14 |
| | Lurgi Corp./Federal Republic of Germany, and Toyo Engineering Corp./Japan | unknown | compound fertilizer plant in Lucheng County, Shanxi | equipment | unknown | Using coal as a raw material, it is to produce 900,000 tons a year of nitrophosphate<br><br>Other projects are ethylene plants at Nanjing, Daqing, and Shandong Province, and another ammonia plant at Yinchuan in the Ninxia Hui Autonomous Region | Sino-British Trade (London), July 1983 p. 14 |
| Apr 83 | Koppers Australia Prt. Ltd./Australia | unknown | Anshan General Chemical Works at the giant Anshan Iron and Steel Complex | design, key equipment, and training for a joint venture to produce coal tar pitch | unknown | Coal tar pitch is used to manufacture electrodes, such as those used in aluminum smelting | Xinhua, in FBIS/China, 13 May 1983, p. E2 |
| May 83 | Scientific Design Company and Halcyon Catalyst Industries/United States, and Toyo Engineering Corp./Japan | unknown | Nanjing Petrochemical Complex | to assist in building ethylene glycol and ethylene oxide plants to produce detergents and synthetic fibers | $10.8 million | -- | Sino-British Trade (London), July 1983, p. 14 |
| Aug 83 | Asahi Chemical Industry Corp. | unknown | Caustic soda plant in Lanzhou | to adopt the bipolar membrane process, a pollution free process that will cut energy costs by 30 percent | $2 million | -- | Sino-British Trade (London), September 1983, p. 14 |

Import of Chemical Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Sep 83 | USS Engineers and Consultants Co., a subsidiary of the United States Steel Corp./United States | Shanghai Gaoqiao Petrochemical Corp. | Shanghai plastics plant | used equipment from an inactive plant of the United States; a limited license for the manufacture of acrylonitrile butadiene styrene, a high-strength, impact-resistant polymer; and commissioning of the new facility and process-design engineering by the USS Engineers and Consultants and a limited amount of consultation on detail engineering | unknown | -- | China Business and Trade (Washington), 10 October 1983, p. 1 |
| Oct 83 | a consortium of Teijin and Nissho Iwai/Japan | unknown | unknown | polyester filament factory in Tianjin | $20 million | The plant will have an annual capacity of 8,000 tons,, and is scheduled to be completed in 1986 | China Trade Report (Hong Kong), October 1983, p. 3 |

## Appendix F

Import of Transportation Equipment Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| 1982 | Standard Thomson and Alleghany Industries Corp./United States | unknown | No. 2 Automotive Plant at Shiyan, Shanxi Province | license production of automotive and truck thermostats | unknown | -- | China Business Review, (Washington), November/December 1983, p. 38 |
| Apr 82 | Perkins Engines/ United Kingdom | unknown | Beijing Motor Vehicle Works | 3,000 Perkins "200" series 2.4-litre diesel engines | unknown | Intended for use in a new overlander cross-country vehicle, which is to be produced for export | Xinhua, 22 April 1982, China Report; Economic Affairs, no. 382, JPRS 80803, 13 May 1982, p. 135 |
| Sep 82 | Parker-Hannifin, Corp./United States | Hubei Motor Vehicle Corp. of Wuhan | Hubei-Parker Seal Maker, a United States-Chinese joint venture | oil-proof and gas-proof rubber seals | unknown | The new factory, using the American partner's machines and up-to-date technology, is to produce oil-proof and gas-proof rubber seals for motor vehicles, ships, and trains | Xinhua, in FBIS/China, 13 September 1982, p. B2 |
| Nov 82 | Volkswagen/Federal Republic of Germany | Shanghai Tractor and Automotive Corp. | Shanghai Automobile Factory | produce Volkswagen's "Santana" model cars | unknown | The plan is to produce 20,000 cars and 100,000 engines per year by 1988, with the 80,000 engines not used in China sold to the Volkswagen Corp.; a November 1983 report quoted a Volkswagen spokesman as saying that negotiations on the joint venture were proceeding too slowly for the venture to be set up in 1983; problems were the speed at which German components for the car would be replaced by Chinese equipment, the | China Daily (Beijing), 17 December 1982, p. 2; Sino-British Trade, (London), November 1983, p. 11 |

Import of Transportation Equipment Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Nov 82 (cont) | | | | | | lack of a double taxation agreement, questions of currency exchange rates, and the vagueness of China's joint venture regulations | |
| Jan 83 | Isuzu Motors Ltd./ Japan | unknown | Nanjing factory | supply designs, molds, and technical know-how for ELF-300 model 3-ton diesel trucks | unknown | Isuzu will also train Chinese technicians | Sino-British Trade (London), March 1983, p. 12 |
| May 83 | American Motors Corp./United States | Beijing Automotive Works | unknown | set up a joint venture to produce jeeps; the American partner will provide the design for the jeep and equipment and technology to produce a four-cylinder engine which will be an improvement on current Chinese engines | unknown | The partners will initially produce an improved version of Beijing's current overland vehicle, which is based on a 30-year-old Soviet design; it will eventually be replaced by a version of AMC's CJ Jeep; Chinese staff will be trained in the United States, and Chinese managers are expected to learn advanced management techniques | Washington Post, 3 May 1983, p. A1; Wall Street Journal (New York), 3 May 1983, p. 37; China Daily (Beijing), 13 December 1983, p. 2 |
| Sep 83 | General Electric Co./United States | Ministry of Railways and Ministry of Machine Building | unknown | license locomotive production technology and purchase 220 electric locomotives from General Electric | unknown | -- | Sino-British Trade (London), October 1983, p. 14; China Business Review (Washington), November/December 1983, p. 43 |
| Sep 83 | unidentified United States company | unknown | Shanghai Heavy-Duty Truck Factory | equipment and technology for manufacturing 35D 32-ton coal mining vehicles | unknown | -- | Sino-British Trade (London), November 1983, p. 14 |

Import of Transportation Equipment Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| 17 Dec 83 | Steyr-Daimler-Puch/ Austria | unknown | unknown | Austrian technology to manufacture heavy-duty trucks | unknown | Steyr-Daimler-Puch to transfer to China all technical documentation, data, and patent rights needed to produce some 10,000 trucks a year; the trucks will include articulated trucks, dump trucks, and cross-country military vehicles; the Austrian firm will also train Chinese technicians and workers, and provide consulting services for the revamping of existing Chinese factories. | China Daily (Beijing), 19 December 1983, p. 2 |

## Appendix G

### Import of Electronics Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Apr 82 | Nippon Electric Co./ Japan | unknown | Dandong Television Parts Factory, Liaoning Province | television tuner production line | unknown | -- | China Business Review (Washington), July/ August 1982, p. 51 |
| Apr 82 | Koa Denko Corp./ Japan | Shanghai Electronics Components Industries | unknown | two plants for carbon-film resistors | unknown | -- | China Business Review (Washington), July/ August 1982, p. 51 |
| Jun 82 | Sanyo Corp./Japan | unknown | Dongfeng Television Factory, Beijing | components for 200,000 television tuners | unknown | agreed to provide technical cooperation | China Business Review (Washington), September/October 1982, p. 56 |
| Aug 82 | Essex Group Inc./ United States | Ministry of Posts and Telecommunications | unknown | renovate a Chengdu factory to produce polyolefine insulated and integral sheathed telephone cables | unknown | -- | Sino-British Trade (London), October 1982, p. 15 |
| Oct 82 | Shinyei Kaisha/ Japan | unknown | unknown | film capacitor plant which will produce polypropylene and polyester film capacitors | unknown | -- | China Business Review (Washington), January/ February 1982, p. 52 |
| Nov 82 | AMF Inc./United States | China's Electrical Components Industrial Corp. | Shanghai Radio Factory | joint production of electrical relays | unknown | -- | Sino-British Trade (London), December 1982, p. 15 |
| Feb 83 | Racal-Dana/United Kingdom | unknown | unknown | establishment of a joint venture for the manufacture and testing of Racal's 9900 Series frequency counters in Shanghai | unknown | the component kits will be shipped from Britain | Sino-British Trade (London), March 1983, p. 13 |

Import of Electronics Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Mar 83 | National Semiconductor Corp./ United States | Shanghai Semiconductor Corp. | unknown | used production equipment | unknown | National Semiconductor had applied for an export license, but was not sure it would receive one; the production line in question could be used to make integrated circuits on 3-inch silicon wafers | Wall Street Journal (New York), 8 March 1983, p. 39 |
| May 83 | Solid State Scientific Corp./United States | China National Technical Import and Export Corp. | unknown | 3-inch wafer fabrication equipment for digital watches | $5.8 million | The contract was subject to export approval by the US Department of Commerce | China Business Review (Washington), September/October 1983, p. 62 |
| Aug 83 | International Scientific/Japan | China Aviation Equipment Corp. | unknown | equipment and technology for the construction of personal computers and semiconductor production lines | $41 million | -- | China Business Review (Washington), November/December 1983, p. 50 |
| Aug 83 | Bishop Graphics Corp./United States; Thai An Trading Co./Hong Kong | Shenzhen Electric Appliances Manufacturing Co. and the Shenzhen branch of the Bank of China | unknown | joint venture to manufacture and distribute a wide range of printed circuit design products | $1 million | One million dollars were to be spent renovating a plant in the Shenzhen Special Economic Zone, adjacent to Hong Kong | Sino-British Trade (London), October 1983, p. 14 |
| Sep 83 | Fuji Electric/Japan | Tianjin No. 3 Semiconductor Parts Factory | unknown | semiconductor manufacturing equipment and related technology | unknown | The equipment will produce 10 million silicon diodes for television sets per year; it includes a wafer chemical-processing line, a diffusion furnace, a metal vapor deposition furnace, and various automatic testing instruments; during the 10-year contract the Japanese company will provide technical assistance, and the Chinese will not export any of the products | China Newsletter (Tokyo), no. 46, September/October p. 21 |

Import of Electronics Technology, 1982-83 (Continued)

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Sep 83 | Nippon Electric Co. Ltd.; Sumitomo Corp./Japan | Tianjin branch of the China National Machinery Import and Export Corp. and the Tianjin Municipal Administration of Posts and Telecommunications | unknown | telephone exchange equipment | unknown | Tianjin will import 10,000 program-controlled telephone exchanges, a number of 1,000-circuit long distance exchanges and 199 32-channel pulse code modulation transmission systems; the Japanese companies will provide meters, maintenance tools and technical services; they will also design the installation, train Chinese personnel in Tianjin and Japan and supply spare parts for 20 years | China Business Review (Washington), November/December 1983, p. 50 |
| Oct 83 | AEG-Telefunken/ Federal Republic of Germany | unknown | Beijing Television Factory | equipment | unknown | New equipment, from Austria, Italy, and the Federal Republic of Germany, will produce 150,000 electronic tuners, 150,000 plastic cabinets, and 60,000 square meters of printed circuit board per year | China Daily (Beijing), 19 October 1983, p. 2 |
| Oct 83 | Yamato Scale Co./ Japan | unknown | Yingkou No. 3 Instruments Plant in Shenyang, Liaoning Province | technology and equipment | $850,000 | Yamato, promises to provide the most advanced technology for electronic belt-balances available | China Trade Report (Hong Kong), November 1983, p. 4 |
| Oct 83 | Micro Air Systems Co./United States | China Electronics Import and Export Corp. | unknown | joint production of semiconductor manufacturing equipment in China | unknown | Spokesman for the company said that none of the technology involved was sufficiently sophisticated to require export approval from the US Department of Commerce, since most of the designs date back to 1976 | China Business and Trade (Washington), 10 October 1983, p. 2 |

## Appendix II

### Import of Computer Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| 1982 | Pacific Data Services Inc./United States | Qinghua University | Qinghua Technical Services | data entry for clients in the United States on two Sperry Univac 1900/10 CADE data entry systems | unknown | By early 1983, the project had 200 Chinese technicians working three shifts a day to enter data at 64 CRT entry stations | China Business Review, (Washington), March/April 1983, pp. 34 & 47 |
| Mar 82 | Core Laboratories Inc./United States | China National Technical Import and Export Corp. | unknown | petroleum engineering computer software | unknown | -- | Sino-British Trade (London), April 1982 p. 14 |
| Jul 82 | Two unspecified Hong Kong firms | Beijing Computer Industry Corp. | Sino On-Line Ltd., Hong Kong | provide product designs for hardware to be manufactured in China; purchase computer accessories, components, spare parts, and other materials to assist the development of China's computer industry; set up a maintenance organization for computing hardware in China and train Chinese technicians in modern computing techniques | unknown | In the initial stage of the venture, 10 Chinese computer experts will go to Hong Kong to be trained by Sino On-Line | South China Morning Post (Hong Kong), 16 July 1982, in FBIS/China, 19 July 1982, pp. W6-7 |

Import of Computer Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Oct 82 | General Robotics Corp./Hartford, Wisconsin/United States | Zhejiang Import Corp., Hangzhou | unknown | 28 computer systems based on Digital Equipment Corp.'s LSI-11/23 central processing unit, General Robotics' BA/800W 8-inch floppy disk and Winchester system chassis and other modules | unknown | -- | Management Information Systems Week (Manasquan, New Jersey), 6 October 1982, p. 25 |
| Oct 82 | Sems Co./France | unknown | Huanan Computer Corp., Guangzhou | production line for the French S-16 minicomputer | unknown | The line has a production capacity of 400 computers per year, and with additional equipment and manpower production can be increased to 1,200 per year; the line went into trial operation in September 1983 | Guangzhou Ribao, 30 October 1982, in China Report: Economic Affairs, no. 312, JPRS 82905, 18 February 1983, p. 31; China Daily (Beijing), 14 September 1983, p. 2 |
| Dec 82 | Robin Information Services/Singapore | China Computer Technology Service Corp.; the Ministry of the Electronics Industry | unknown | set up a data entry service in Beijing | unknown | Robin Information Services provides equipment and expertise and China provides labor | China Business Review, (Washington), March/April 1983, pp. 34 & 47 |
| Jun 83 | Santec Corp./Amherst, New Hampshire/United States | Nanjing Telecommunications Works | unknown | joint venture to develop, produce, and market printers | $2 million | The Chinese side to receive technical assistance in developing printers and word processing equipment, while Santec, which operated at a loss in 1982, to receive labor intensive parts | Wall Street Journal (New York), 13 June 1983, p. 8; Washington Post, 16 June 1983, p. D17 |

Import of Computer Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Jun 83 | IBM/Japan | unknown | Bright Star Computer Service Center, Beijing | Training of 12 Chinese students who were to work in the new service center | unknown | In September, a special training course at Chinese Academy of Science's Computer Center began for 23 specialists who will work with IBM computers used to analyze data from the 1981 Chinese census; most of the specialists had received 4-months training from IBM in New York in 1982 | China Daily (Beijing), 18 September 1983, p. 2 |
| Aug 83 | Consortium of seven Japanese software firms/Japan | China Electronics Import and Export Corp.; the Beijing Computer Corp.; the China Computer Technical Services Center | joint venture to be called the Beijing Core Software Corp. | produce software for microcomputers used in Chinese factory automation and hotel systems; the software will be marketed in Japan | unknown | -- | Kyodo (Tokyo), 11 August 1983, in FBIS/China, 11 August 1983, p. D1; China Business and Trade (Washington), 21 August 1983, p. 2 |
| Sep 83 | Sinclair/United Kingdom | China National Electronics Import and Export Corp.; the South China Computer Corp. | unknown | ZX81 and Spectrum home computers in kit form for assembly in a new factory in Guangzhou | unknown | Chinese technicians will be trained in the United Kingdom, and Sinclair will mount exhibitions and hold seminars in Guangzhou, Shanghai, and Beijing | Sino-British Trade (London), October 1983, p. 14 |

Appendix I

Import of Aviation Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Jul 82 | World Jet Aircraft/ United States | General Administration of Civil Aviation, China | unknown | two CFM-56-2 jet engines for prototype re-engineering of China's Trident aircraft | unknown | -- | China Business Review (Washington), November/December 1982, p. 48 |
| Jul 82 | International Civil Aviation Association | General Administration of Civil Aviation, China | unknown | technical assistance and help training maintenance engineers and air traffic engineers | unknown | -- | China Business Review (Washington), November/December 1982, p. 48 |
| Nov 82 | Boeing Corp./United States | General Administration of Civil Aviation, China | unknown | 10 B-737-200 jet airliners | $160 million | -- | China Business Review (Washington), January/February 1983, p. 54 |
| Dec 82 | Aust-Paoyi/Australia | unknown | "an as-yet undisclosed project" | a prototype cargo-carrying airship (lighter-than-air craft) | unknown | -- | China Business Review (Washington), March/April 1983, p. 49 |
| Jan 83 | Air-Logistics International/United States | General Administration of Civil Aviation, China | unknown | supply of helicopters and technical services by Air-Logistics | unknown | The helicopters are to be used to support oil exploration in the South China Sea | China Business Review (Washington), March/April 1983, p. 47 |
| May 83 | Boeing Corp./United States | China National Aerotechnology Import and Export Corp. (CATIC) | unknown | training 15 Chinese engineers in the design and manufacture of aircraft at Boeing's Seattle factory | unknown | Boeing also has a compensation trade agreement with CATIC, in which machine parts for B737s and B-747s are made at the aircraft factory at Xi'an | China Business Review (Washington), May/June 1983, p. 10 |

Import of Aviation Technology, 1982-83

| Date | Foreign Firm/Country | Chinese Firm | Chinese End User | Item | Value (US dollars) | Comment | Source |
|---|---|---|---|---|---|---|---|
| Jun 83 | Hong Kong Aircraft Engineering Corp./ Hong Kong | China National Aerotechnology Import and Export Corp. | unknown | a joint venture, South China Aerotechnology headquartered in Hong Kong is to promote the transfer of aviation technology to China and to market Chinese aviation products abroad | unknown | -- | Sino-British Trade (London), July 1983, p. 14 |
| Jun 83 | CompAir Reavell/ United Kingdom | China National Aerotechnology Import and Export Corp. | unknown | test equipment for the development of jet engines | unknown | -- | China Business Review November/December 1983, p. 52 |
| 5 Jun 83 | Quickie Aircraft Corp./United States | unknown | Shanghai Aircraft Factory | assemble the single-engine light aircraft at Shanghai from parts and materials supplied by Quickie | unknown | The planes are to be sold overseas | Jiefang Ribao (Shanghai), 5 June 1983, in China Report: Science and Technology, no. 203, JPRS 83910, 18 July 1983, p. 3 |

## NOTES

[1] Zhao Ziyang, "Report on the Sixth Five-Year Plan," Beijing Review, 20 December 1982, p. 28.

[2] Richard Nations, "Raising the Barriers," Far Eastern Economic Review, (Hong Kong), 16 June 1983, pp. 16-18; Xinhua, 22 June 1983, in Foreign Broadcast Information Service, Daily Report, China (hereafter FBIS/China), 22 June 1983, p. B1.

[3] Zheng Hongqing, "Opening to the Outside World and Self-Reliance," Beijing Review, 14 March 1983, p. 18.

[4] US, Congress, Joint Economic Committee, Hans Heymann Jr., "Acquisition and Diffusion of Technology in China" in China: A Reassessment of the Economy, 94th Cong., 1st sess., 1975, p. 686.

[5] Cheng Chu-yuan, Scientific and Engineering Manpower in Communist China, 1949-1963 (Washington, D.C.: National Science Foundation, 1965). p. 196.

[6] Heymann, "Acquisition and Diffusion of Technology in China," p. 686.

[7] US, Congress, Joint Economic Committee, Denis Fred Simon, "China's Capacity to Assimilate Foreign Technology: An Assessment" in China Under the Four Modernizations: Part 1, 97th Cong., 2d sess., 13 August 1982, p. 544.

[8] Heymann, "Acquisition and Diffusion of Technology in China," p. 703.

[9] Zhang Shuguang, "Two Keys to Industrial Development," Beijing Review, 31 January 1983, p. 16.

[10] Ibid., p. 18.

[11] Wu Jing, "Prospects of China's Coal Industry," Beijing Review, 12 September 1983, p. 14.

[12] Rudi Volti, Technology, Politics and Society in China (Boulder, Colorado: Westview Press, 1982). p. 163.

[13] Xinhua in China Daily (Beijing), 12 January 1983, p. 2.

[14] Volti, Technology, Poltics and Society in China, p. 161.

[15] Sino-British Trade (London), February 1983, p. 2.

[16] Christopher Clarke, "China's Energy Plan for the 80's," China Business Review (Washington, D.C.), May/June 1981, p. 48.

[17] Volti, Technology, Politics and Society in China, p. 163.

[18] Kim Woodward, "China in Asia's Energy Development," in Critical Energy Issues in Asia and the Pacific: The Next Twenty Years, ed. F. Fesharaki, et al. ed. (Boulder Colorado: Westview Press, 1981). p. 193.

[19]Kim Woodward, "China and Offshore Energy," Problems of Communism (Washington, D.C.), November/December 1981, p. 36.

[20]China Trade Report (Washington, D.C.), July 1980, p. 8.

[21]Asian Wall Street Journal (Hong Kong), 6 September 1983, p. 1.

[22]Kim Woodward, "US Oil Industry Looks for Shot in the Arm," Petroleum News (Hong Kong), April 1983, p. 38.

[23]Martin Weil, "Hydropower," China Business Review (Washington, D.C.), July/August 1982, p. 20.

[24]Ibid., p. 19.

[25]Ibid., p. 24-25.

[26]China Daily (Beijing), 17 October 1982, p. 1.

[27]China Daily (Beijing), 12 November 1982, p. 2.

[28]Xinhua, 23 December 1982, in FBIS/China, 27 December 1982, p. K2.

[29]Ta Kung Pao Weekly Supplement (Hong Kong), 20 January 1983, p. 1.

[30]Agence France-Presse, 5 May 1983, in FBIS/China, 6 May 1983, p. G2; Washington Post, 5 May 1983, p. A20.

[31]Agence France-Presse, 27 March 1983, in FBIS/China, 29 March 1983, p. G2.

[32]Agence France-Presse, 27 December 1982, in FBIS/China, 29 December 1982, p. G4.

[33]Far Eastern Economic Review (Hong Kong), 19 May 1983, p. 80.

[34]Larry Chow, "Will Guangdong N-Plant Get Built?" Petroleum News (Hong Kong), August 1983, pp. 9-10.

[35]China Business and Trade (Washington, D.C.), 21 January 1983, p. 1.

[36]China Daily (Beijing), 17 July 1983, p. 1; Far Eastern Economic Review (Hong Kong), 28 July 1983, pp. 14-15.

[37]Nucleonics Week (New York), 27 October 1983, p. 3.

[38]Kyodo, 3 September 1981, in FBIS/Asia and Pacific, 3 September 1981, p. C5.

[39]Xinhua, 17 October 1981, in FBIS/China, 19 October 1981, p. B5; Sino-British Trade (London), January 1983, p. 3.

[40]Cheng Chu-yuan, "China's Industrialization and Economic Development," Current History (September 1983), p. 267.

[41]Journal of Nanjing University, no. 1, 1980, cited in Cheng, "China's Industrial and Economic Development," p. 268.

[42]China Daily (Beijing), 17 February 1983, p. 4.

[43]Maruyama Nobuo, "The Mechanism of China's Industrial Development," The Developing Economies (Tokyo), vol. 20, no. 4 (December 1982), p. 456.

[44]Japan External Trade Organization (JETRO), China Newsletter (Tokyo), no. 46 (September-October 1983), p. 23; US Central Intelligence Agency, China: International Trade: First Quarter, 1983 (Washington, D.C.), September 1983, p. 13.

[45]Sino-British Trade (London), April 1983, p. 11.

[46]Beijing Review, 18 April 1983, p. 9.

[47]Wall Street Journal (New York), 9 June 1983, p. 37.

[48]China Daily (Beijing), 18 September 1983, p. 2.

[49]Cheng Chu-yuan, China's Economic Development: Growth and Structural Change (Boulder, Colorado: Westview Press, 1982). p. 442.

[50]Guangming Ribao (Beijing), 7 April 1981, p. 2, translated in Joint Publications Research Service (JPRS) 78309, 16 June 1981, China Report: Economic Affairs, no. 143, pp. 46-48.

[51]China, State Statistical Bureau, Statistical Yearbook of China 1981 (English edition, Hong Kong, 1982), pp. 279-286; Robert W. Smith, "The Role of China's Transport in Industrial Modernization," in China Trade: Prospects and Problems, eds. D. Buxbaum, C. Joseph and P. Reynolds (New York: Praeger, 1982), pp. 197-202; Volti, Technology, pp. 186-187.

[52]Volti, Technology, Politics and Society in China, pp. 194-95.

[53]"Development of Semiconductor Integrated Circuits in Our Nation," Dianzi Shijie [Electronic World] (Beijing, December 1981), in China Report: Science and Technology, no. 162, JPRS 80888, 24 May 1982,' pp. 16-20; "Do a Good Job in Readjustment, Develop the Electronics Industry," Renmin Ribao (Beijing), 14 May 1981, in China Report: Economic Affairs, no. 142, JPRS 78257, 9 June 1981, pp. 24-27.

[54]Renmin Ribao, 14 May 1981.

[55]China Trade Report (Hong Kong), November 1982, p. 12.

[56]Chris Brown, "Semiconductors," China Business Review (Washington, D.C.), May/June 1982, pp. 46-47; Federal Register, vol. 48, no. 227, 23 November 1983, p. 53069.

[57]China Business Review (Washington, D.C.), May/June 1982, p. 48.

[58] China Business Review (Washington, D.C.), September/October 1983, pp. 40-42; Wall Street Journal (New York), 21 July 1983, p. 52; Xinhua, 30 July 1983, in FBIS/China, 1 August 1983, p. C1.

[59] China Daily (Beijing), 8 December 1983, p. 1.

[60] Chris Brown, "Computer Sales," China Business Review (Washington, D.C.), March/April 1983, p. 33.

[61] Vaughn Mantor, "Can The People's Republic Catch Up?" Computerworld (Framingham, Massachusetts), 14 November 1983, p. 21-22.

[62] Tao Shi, "Five Problems Which Need to be Urgently Solved in China's Microcomputer Development," Jisuanji Shijie [China Computerworld] (Beijing), October 1982, in China Report: Science and Technology, no. 185, JPRS 82739, 26 January 1983, p. 12.

[63] Chen Liwei, "China's Goal to Build Own Computer Industry," Computerworld (Framingham, Massachusetts), 14 November 1983, p. 32.

[64] China Business Review (Washington, D.C.), March/April 1983, p. 36.

[65] Mantor, "Can The People's Republic Catch Up?," pp. 21-22.

[66] Wang Zinggang, "Some Views in Computer Development in China," Ziran Bianzhengfa Tongzun [Journal of Dialectics of Nature] (Beijing), December 1982, in China Report: Science and Technology, 22 June 1983, JPRS 83733, pp. 15-19.

[67] China Daily (Beijing), 18 May 1983, p. 1.

[68] China Business Review (Washington, D.C.), March/April 1983, p. 34.

[69] Ibid, p. 34.

[70] Eve Rodler, "Service Centers in China," China Business Review (Washington, D.C.), September/October 1983, p. 45-50.

[71] Aviation Week and Space Technology (New York), 9 June 1980, pp. 18-19; 3 May 1982, p. 66.

[72] David L. Shambaugh, "China's Defense Industries: Indigenous and Foreign Procurement" in The Chinese Defense Establishment, ed. Paul H. B. Godwin (Boulder, Colorado: Westview Press, 1983). p. 51-52.

[73] China Daily (Beijing), 3 March 1983, p. 3.

[74] Aviation Week and Space Technology (New York), 12 July 1977, p. 16; Xinhua, 31 October 1979, in FBIS/China, 1 November 1979, p. G2.

[75] Harlan W. Jencks, From Muskets to Missiles (Boulder, Colorado: Westview Press, 1982). pp. 197-98; China Business Review (Washington, D.C.), November/December 1983, p. 41.

[76] The Economist (London), 14 May 1983, pp. 55-56.

[77] Armed Forces Journal International (Washington), November 1983, p. 90.

[78] Philip J. Klass, "Avionics in China: CAAC Modernizes its Air Traffic Control," Aviation Week and Space Technology (New York), 13 June 1983, pp. 79-89.

[79] China Business Review (Washington, D.C.), March/April 1981, p. 25.